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Spatio-Temporal Trends in Oilseed Crop Production in Haryana: A District-Level Analysis

Amandeep Gahlawat

Research Scholar, Baba Mastnath University, Asthal Bohar, Rohtak, Haryana, India

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Abstract— *This study provides a spatio-temporal analysis of oilseed crop production across Haryana, focusing on comparative data from 2013–14 and 2023–24. The objective is to understand regional variations in cultivation area and output, identify emerging trends, and evaluate the effectiveness of agricultural policies promoting oilseed farming. The analysis reveals that districts such as Bhiwani, Mahendragarh, Hisar, Sirsa, and Rewari dominate both areas under cultivation and total production, highlighting their continued significance in the oilseed sector. Over the decade, these regions have shown marked increases in output, suggesting the adoption of improved technologies, seed varieties, and favorable climatic conditions. Conversely, eastern and urban-adjacent districts like Karnal, Kurukshetra, and Gurugram display limited involvement in oilseed cultivation, indicating ongoing reliance on alternative high-value or staple crops. The emergence of districts such as Charkhi Dadri and Nuh as notable contributors reflects diversification trends and a shift towards more sustainable farming systems. This spatial variation underscores the importance of district-level planning and region-specific strategies for balanced agricultural development. By analyzing secondary data from the Statistical Abstract of Haryana and government sources, the study offers valuable insights into the evolving oilseed landscape, aiding policymakers, planners, and researchers in enhancing productivity and promoting sustainable agricultural practices.*

Keywords— ***OilSeeds, Spatio-Temporal, Sustainable Agriculture, Mechanization of Agriculture.***

I. INTRODUCTION

Agriculture has long been the backbone of Haryana's economy, providing livelihoods to a significant portion of its population and making a notable contribution to the state's Gross State Domestic Product (GSDP). While Haryana is traditionally known for its dominance in wheat and rice cultivation, the oilseed sector has emerged as a significant component of the agricultural landscape in recent decades. Among oilseed crops, mustard, rapeseed, groundnut, soybean, and sunflower constitute the major varieties cultivated in the state. The increasing emphasis on crop diversification, sustainability, and the need to adapt to water scarcity and climatic challenges has shifted attention toward oilseeds as a viable alternative. As a result, the oilseed cultivation scenario in Haryana has undergone considerable spatio-temporal transformations over the last two decades.

Oilseed production in Haryana has seen a notable upward trend in both area and yield. According to the Statistical Abstracts of Haryana and various agricultural reports, the area under oilseed crops, particularly rapeseed and mustard, has increased consistently from the early 2000s to the early 2020s. This shift is driven by several factors, including reducing dependence on water-intensive crops, government incentives like the Minimum Support Price (MSP), and advancements in oilseed technologies such as high-yielding varieties and improved agronomic practices. Moreover, oilseeds require less water and inputs than cereals like paddy, making them attractive for regions experiencing groundwater depletion and soil degradation due to intensive farming practices.

The spatio-temporal dimension of oilseed cultivation in Haryana provides a compelling narrative of agricultural change. Spatially, the spread of oilseed crops has been uneven, with concentration in areas where climatic conditions, soil texture, and irrigation availability favor their growth. Temporally, significant shifts are evident in the cultivation patterns, indicating farmers' changing

preferences, influenced by market demand, price volatility, and policy frameworks. Over time, areas that were earlier under monoculture cereals have shown an increased tendency to diversify into oilseeds, especially during the rabi season. This shift not only represents an adaptation to environmental constraints but also signals a strategic reorientation in the state's agricultural economy.

Technological and policy interventions have played a crucial role in influencing these spatio-temporal trends. Implementing agricultural extension programs, promoting oilseed-based cropping systems, and ensuring timely credit and input supply availability have encouraged farmers to embrace oilseed cultivation. The National Mission on Oilseeds and Oil Palm (NMOOP) and other state-level initiatives have provided subsidies on seeds, fertilizers, and farm machinery, enhancing production efficiency. Furthermore, integrating geospatial tools and satellite-based monitoring has enabled better assessment and forecasting of oilseed crop area and yield, contributing to more informed planning and policy decisions.

Environmental considerations have also influenced the expansion of oilseed cultivation. Haryana faces increasing stress on natural resources, particularly water. Though productive, the traditional rice–wheat cropping system is resource-intensive and unsustainable in the long term. In contrast, oilseed crops require fewer irrigation cycles and are relatively tolerant to varying climatic conditions. This makes them suitable for sustainable intensification, especially in areas where groundwater levels are receding and rainfall variability is increasing. As climate change projections indicate rising temperatures and erratic rainfall patterns, cultivating drought-tolerant crops like mustard and soybeans becomes crucial in ensuring food and economic security for the farming community.

Socio-economic factors have also shaped the spatial and temporal dynamics of oilseed production. Landholding size, access to institutional support, market proximity, and farmer awareness play a decisive role in adopting oilseed crops. Regions with better infrastructure, access to procurement centers, and active agricultural extension networks have shown a faster rate of oilseed adoption. On the other hand, marginal and small farmers with limited access to resources often face challenges in transitioning to alternative crops, highlighting the need for inclusive policy interventions.

Research and development in oilseed agronomy have significantly contributed to yield improvements and area expansion. High-yielding varieties with resistance to pests and diseases, coupled with precision farming techniques, have led to increased productivity. Additionally, timely sowing, integrated nutrient management, and mechanization of harvesting processes have further enhanced the economic viability of oilseed farming. Public and private sector collaboration in research has ensured the continuous supply of improved seed material and information dissemination, which are vital for maintaining production momentum.

From a policy perspective, the spatio-temporal analysis of oilseed crops is a critical tool for agricultural planning and resource allocation. It helps identify high-potential zones for oilseed cultivation, assess regional disparities, and evaluate the impact of past interventions. Such analysis is vital for refining existing strategies and formulating targeted programs that address the unique agro-ecological and socio-economic conditions of different regions within the state. Moreover, it contributes to national goals of reducing edible oil import dependency, improving farmer incomes, and promoting sustainable agriculture.

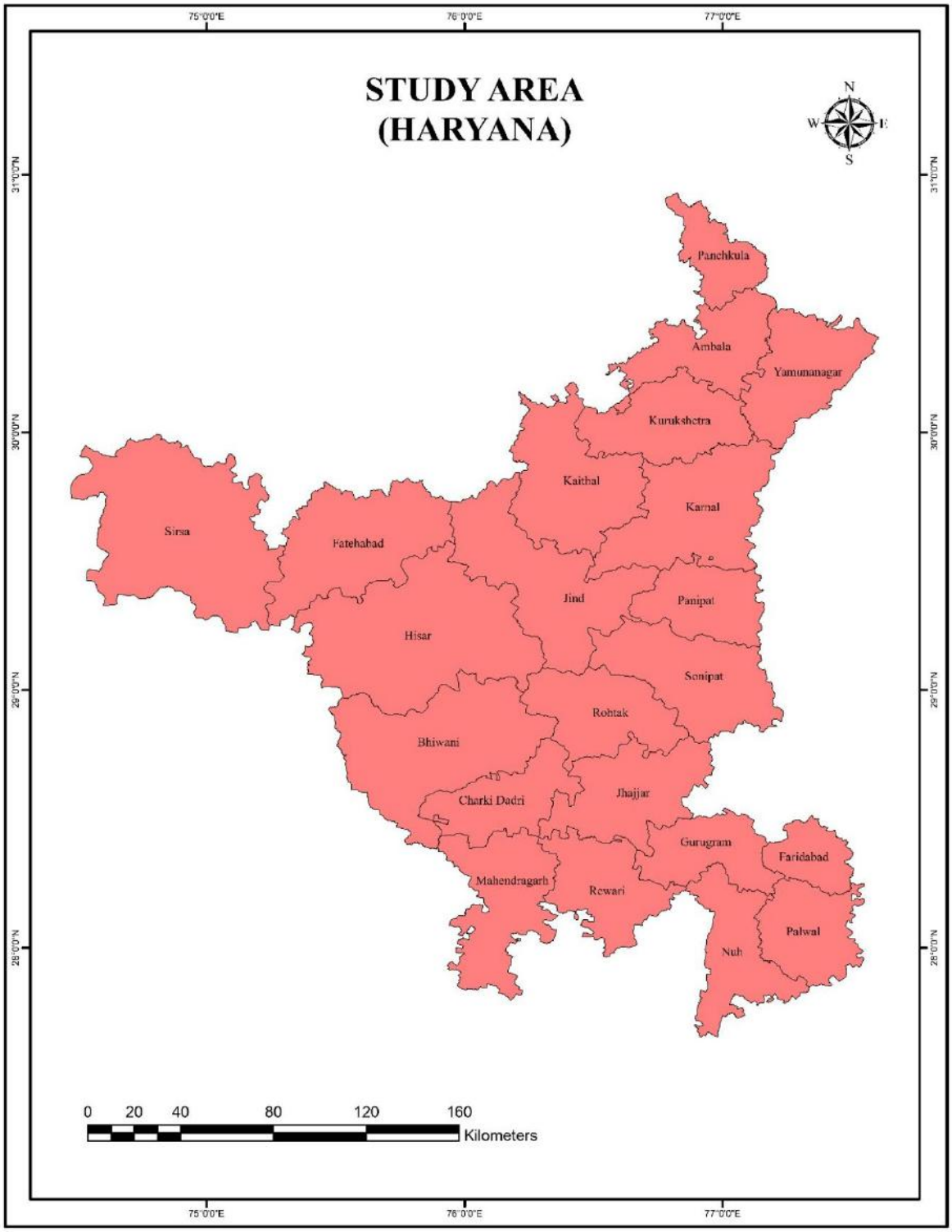
The data from the last two decades indicates a rising trend in the area under oilseed cultivation and the productivity of these crops. This trend, however, is not uniform across the state, necessitating a district-level analysis to understand localized patterns and their underlying causes. The study of these patterns, through spatio-temporal analysis, provides a comprehensive understanding of how different factors—natural, economic, and institutional—interact over time and space to shape agricultural outcomes. It also enables the identification of emerging trends, constraints, and opportunities for further development of the oilseed sector.

Significance of the Study: -

The significance of studying spatio-temporal trends in oilseed crop production in Haryana lies in its capacity to inform sustainable agricultural planning, resource optimization, and regional economic development. Haryana, predominantly an agrarian state, has historically focused on wheat and rice cultivation. However, overexploitation of water resources and declining soil fertility have raised concerns about the sustainability of traditional cropping patterns. In this context, oilseed crops—especially mustard, groundnut, and sunflower—have emerged as viable alternatives due to their lower water requirements, climate resilience, and economic potential. This study is crucial for understanding how oilseed cultivation has evolved spatially across different agro-climatic regions of the state and temporally over the years, reflecting responses to environmental, policy, and market changes. By identifying areas with increasing or declining trends in oilseed production, the study aids in recognizing the regions best suited for oilseed-based cropping systems. This enables policymakers to promote targeted interventions in high-potential zones, such as

input subsidies, irrigation management, and extension services.

Moreover, the study contributes to national efforts to reduce India's dependency on imported edible oils by highlighting the production potential of Haryana's agricultural landscape. It also supports the goals of doubling farmers' income and promoting climate-smart agriculture. The district-level analysis enriches the academic understanding of regional disparities and agrarian transformation, providing a foundation for further research.



Map No. 1: Study Area

Source: Compiled by Researcher

Study Area: -

Haryana, situated in northern India, was established in 1966 following its separation from the former state of Punjab. Geographically, it lies between latitudes 27°39' N and 30°35' N, and longitudes 74°28' E and 77°36' E. The state shares its boundaries with Punjab, Himachal Pradesh, Rajasthan, and Uttar Pradesh, and strategically encircles the national capital, Delhi, on three sides. Covering a total area of approximately 44,212 square kilometers, Haryana is divided into 22 districts and administratively organized into six divisions: Ambala, Rohtak, Hisar, Gurugram, Karnal, and Faridabad.

According to the 2011 Census of India, the state's population exceeded 2.53 crore, with projections indicating an increase to over 2.9 crore by 2024. Haryana ranks among India's more economically progressive states, with significant industrial development, particularly in districts such as Gurugram, Faridabad, and Panipat. Despite this industrial growth, a large proportion of the population—around 65%—continues to reside in rural areas. The state has a literacy rate of 75.55%, and as per the 2011 Census, a sex ratio of 929 females per 1,000 males, a figure that has been gradually improving (Census of India, 2011).

Objectives: -

i. To analyze the spatial distribution of major oilseed crops.
ii. To assess productivity trends of oilseed crops and identify regions with high or low Productivity.

II. RESEARCH METHODOLOGY AND DATABASE

The present study, titled "Spatio-Temporal Trends in Oilseed Crop Production in Haryana: A District-Level Analysis," is based entirely on secondary data sources and adopts a descriptive-analytical research methodology to examine the patterns and changes in oilseed crop cultivation across the state over a defined period. The study primarily utilizes data from the Statistical Abstract of Haryana for 2013–14 and 2023–24, published by the Department of Economic and Statistical Analysis, Government of Haryana. These abstracts provide comprehensive district-wise information on the area under oilseed crops and total production, allowing for a comparative analysis over the last decade. Additionally, Census of India 2011 data have been used to understand the demographic and socio-economic context of agricultural practices, particularly rural population distribution, that may influence oilseed production.

The methodology involves the total Area and Production of oilseed crops grown in Haryana, such as mustard, sunflower, and groundnut, and a comparative assessment of their spatial distribution and production performance across different districts. Analytical techniques like graphical representation are applied to highlight shifts in cropping patterns. Furthermore, the study correlates changes in oilseed production with factors such as access to irrigation, level of mechanization, input availability, and government support policies, based on relevant government publications and reports. By focusing on a spatio-temporal lens, the methodology aims to reveal regional disparities, developmental gaps, and emerging trends in oilseed cultivation. The insights generated from this analysis are expected to contribute to more informed decision-making in agricultural planning and policy, especially concerning crop diversification and oilseed promotion in Haryana.

III. RESULTS AND DISCUSSION

A critical component of the research process, particularly in agricultural studies like oilseed crop analysis, is the thorough examination and interpretation of data. This stage involves evaluating secondary data, such as area under cultivation, production levels, and yield rates, from official sources like the Statistical Abstracts of Haryana to extract meaningful insights. The process begins with analysis, which entails systematically organizing and reviewing raw data to identify trends, spatial disparities, and temporal shifts in oilseed crop patterns across the state. However, analysis alone is not sufficient. Without interpretation, these numerical trends remain incomplete and lack relevance. Interpretation brings data to life by contextualizing findings within the broader framework of agricultural policies, climatic factors, market dynamics, and rural socio-economic conditions.

In the case of oilseeds, interpretation may reveal how rainfall fluctuations or irrigation access influence productivity in certain regions, or how government initiatives have impacted the area under mustard or sunflower cultivation. Interpretation helps bridge the gap between statistical figures and real-world agricultural practices, making it possible to draw logical, policy-relevant conclusions. The mutual dependency of analysis and interpretation is especially vital in oilseed research because it ensures the findings are statistically sound and practically significant. Together, they enable researchers to assess performance, identify challenges, and recommend strategies for enhancing oilseed production in Haryana. This dual approach forms the foundation for evidence-based planning, resource allocation, and promoting sustainable crop diversification in the state's agriculture.

Table No. 1: Area and Production of Oilseeds in Haryana (2013-14)

Sr. No.	Districts	OilSeeds	
		Area	Production
1.	Ambala	1.5	2.5
2.	Panchkula	1.8	3.5
3.	Yamunanagar	3.5	4.3
4.	Kurukshetra	5.5	3.9
5.	Kaithal	0.9	2.0
6.	Karnal	1.1	2.0
7.	Panipat	0.9	2.0
8.	Sonipat	2.4	3.0
9.	Rohtak	13.7	20.1
10.	Jhajjar	35.6	19.2
11.	Faridabad	0.6	1.0
12.	Palwal	3.9	7.0
13.	Gurgaon	14.6	28.2
14.	Mewat	29.1	46.1
15.	Rewari	67.6	145.2
16.	Mahendragarh	96.7	165.1
17.	Bhiwani	162.6	265.4
18.	Jind	4.6	8.0
19.	Hisar	62.4	103.9
20.	Fatehabad	13.0	20.4
21.	Sirsa	45.6	77.2

Source: Statistical Abstract of India, 2013-14

The spatial distribution of oilseed cultivation across the districts of Haryana offers significant insight into the state's agro-economic dynamics. The data reveals pronounced disparities in the area under cultivation and the corresponding production levels of oilseed crops, reflecting differences in climatic conditions, soil fertility, irrigation facilities, and agricultural practices. A close examination of district-wise statistics shows a concentration of oilseed farming predominantly in the southern and western parts of the state. At the same time, the northern and eastern districts contribute relatively less in terms of both area and output.

Bhiwani district is at the forefront of oilseed production in Haryana, which leads with a vast cultivation area of 162.6 thousand hectares and a corresponding production of 265.4 thousand tonnes. This exceptional performance can be attributed to Bhiwani's semi-arid climate, large tracts of cultivable land, and traditional reliance on dryland farming systems suitable for oilseed crops like mustard. Mahendragarh follows with 96.7 thousand hectares and 165.1 thousand tonnes of production. Together with Rewari, which reports 67.6 thousand hectares and 145.2 thousand tonnes, these districts form the high-performing belt of oilseed agriculture. The dominance of these regions is primarily influenced by limited irrigation facilities, which make oilseed cultivation preferable over water-intensive crops like paddy. Furthermore, mustard—Haryana's leading oilseed crop—is well suited to these agro-climatic conditions.

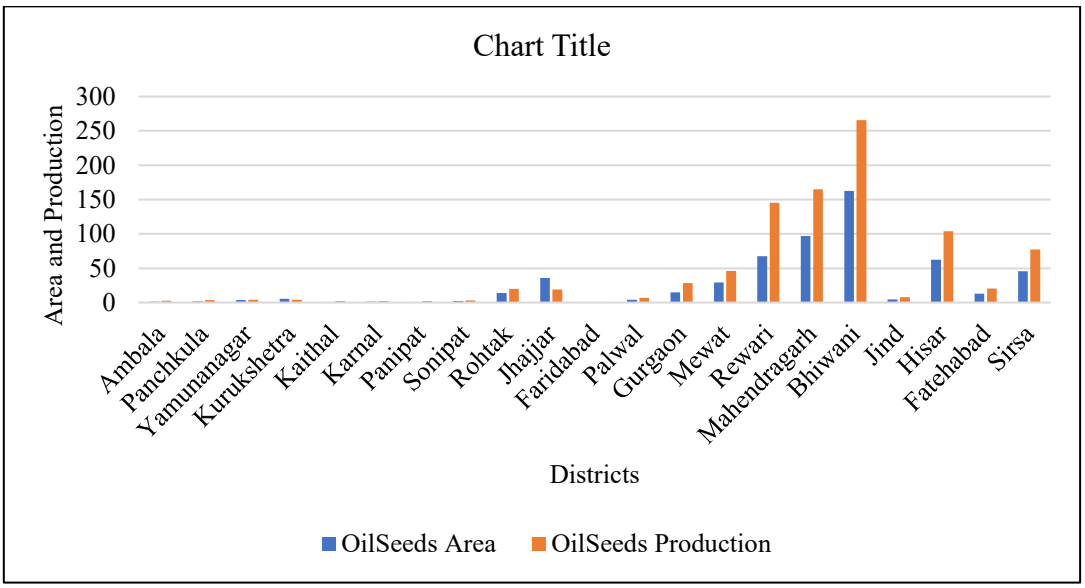


Fig 1. Area and Production of Oilseeds in Haryana (2013-14)

Source: Table No. 1

In contrast, districts like Faridabad and Panipat exhibit minimal engagement in oilseed farming, each with only 0.6 and 0.9 thousand hectares under cultivation and 1.0 and 2.0 thousand tonnes of production, respectively. The lower figures in these districts can be explained by their highly urbanized landscapes and industrial development, leading to a shrinkage of agricultural land. Similarly, Karnal, Kaithal, and Kurukshetra—although agriculturally intensive—tend to favor paddy-wheat crop rotations due to the availability of canal irrigation and better water management infrastructure, which are less compatible with oilseed farming.

Interestingly, Mewat (Nuh) and Gurgaon (Gurugram) also show substantial involvement in oilseed cultivation, with 29.1 thousand hectares and 46.1 thousand tonnes in Mewat, and 14.6 thousand hectares and 28.2 thousand tonnes in Gurgaon. Despite being close to the National Capital Region (NCR), these districts have maintained a strong rural agricultural identity. Mewat in particular has emerged as a significant contributor, which may be due to focused government interventions, schemes for dryland farming, and local dependence on traditional crops. The substantial production in Hisar (103.9 thousand tonnes) and Sirsa (77.2 thousand tonnes) also highlights the importance of western Haryana as a stronghold for oilseed cultivation. These districts benefit from extensive arable land and a combination of traditional agricultural knowledge and technological support.

The central districts show a mixed trend. Rohtak, for instance, presents a moderate level of cultivation with 13.7 thousand hectares and 20.1 thousand tonnes of output. In comparison, Jhajjar shows a large area under cultivation (35.6 thousand hectares) but a lower comparative yield (19.2 thousand tonnes), indicating possible inefficiencies or constraints such as soil degradation, low input use, or limited access to modern agronomic practices. On the other hand, Palwal, with 3.9 thousand hectares and 7.0 thousand tonnes, shows relatively higher productivity per hectare, suggesting the use of better inputs or more favorable growing conditions.

The figures remain on the lower side in the northern districts such as Ambala, Panchkula, and Yamunanagar. Ambala reports 1.5 thousand hectares and 2.5 thousand tonnes, Panchkula 1.8 and 3.5, and Yamunanagar 3.5 and 4.3, respectively. These figures reflect the region's stronger emphasis on sugarcane, paddy, and horticulture. Their better irrigation and proximity to markets likely influence cropping choices that are more profitable or aligned with local demand.

A notable observation is yield efficiency, inferred from the production ratio to area. Districts like Palwal, Gurgaon, and Rewari demonstrate relatively higher productivity, indicating efficient use of inputs such as fertilizers, high-yielding seed varieties, and modern farming techniques. For example, with 67.6 thousand hectares, Rewari produces 145.2 thousand tonnes, nearly 2.15 tonnes per hectare, which is considerably higher than Jhajjar's approximate 0.54 tonnes per hectare. This variation indicates the need for location-specific agronomic interventions and extension services to improve outcomes in lagging districts.

The data also underscores the spatial imbalance in oilseed production, where a few districts disproportionately contribute to the state's total output. This has implications for agricultural planning and food security policies. Encouraging crop diversification in water-stressed regions by promoting oilseeds can be a sustainable solution. Moreover, enhancing oilseed productivity in underperforming but potential districts through better seeds, extension services, and financial incentives would help reduce import dependency and ensure farmers' price stability.

Table No. 2: Area and Production of Oilseeds in Haryana (2023-24)

Sr. No.	Districts	OilSeeds	
		Area	Production
1.	Ambala	11.8	17.5
2.	Bhiwani	170.6	298.1
3.	Charkhi Dadri	77.2	148.1
4.	Faridabad	1.9	3.6
5.	Fatehabad	26.1	45.4
6.	Gurugam	29.9	57.9
7.	Hisar	108.3	206.7
8.	Jhajjar	48.3	96.1
9.	Jind	14.2	30.5
10.	Kaithal	5.8	10.8
11.	Karnal	5.5	11.0
12.	Kurukshetra	17.5	21.7
13.	Mahendragarh	112.4	229.2
14.	Nuh	40.3	82.8
15.	Palwal	7.2	13.7
16.	Panchkula	2.7	5.6
17.	Panipat	3.8	8.6
18.	Rewari	85.8	166.3
19.	Rohtak	15.0	26.3
20.	Sirsa	106.6	205.9
21.	Sonipat	7.1	13.5

22.	Yamunanagar	5.6	7.1

Source: Statistical Abstract of India, 2023-24

The spatial distribution of oilseed crop cultivation in Haryana reveals substantial regional disparities in both area under cultivation and total production. This data offers insight into how geographical, climatic, infrastructural, and socio-economic factors influence agricultural practices, particularly in oilseed farming. The 2023–24 data shows that oilseed cultivation is significantly more prominent in Haryana's southern and western districts, while northern and central parts show limited engagement in this crop sector.

Bhiwani emerges as the leading district, with 170.6 thousand hectares under oilseed cultivation and a production of 298.1 thousand tonnes. This performance can be attributed to Bhiwani's arid and semi-arid conditions, where oilseeds such as mustard are preferred due to their low water requirements. Similarly, Mahendragarh and Hisar also demonstrate substantial contributions, with 112.4 and 108.3 thousand hectares in area and 229.2 and 206.7 thousand tonnes in production, respectively. These districts benefit from large tracts of cultivable land, established agronomic practices for oilseeds, and relatively limited irrigation facilities that make oilseeds a more viable crop option than water-intensive alternatives like paddy.

Charkhi Dadri, a newer district carved out of Bhiwani, follows the same trend with 77.2 thousand hectares and 148.1 thousand tonnes, indicating its alignment with the oilseed-friendly agro-ecological zone of southwest Haryana. Rewari and Sirsa are other significant contributors, registering 85.8 and 106.6 thousand hectares, and 166.3 and 205.9 thousand tonnes respectively. These figures establish the dominance of the western belt of Haryana in oilseed production. On the other hand, districts such as Faridabad (1.9 thousand hectares, 3.6 thousand tonnes) and Panipat (3.8 thousand hectares, 8.6 thousand tonnes) show minimal involvement in oilseed farming. These areas are characterized by rapid urbanization and industrial expansion, which has reduced the availability of cultivable land. Moreover, farmers in these regions are more likely to focus on high-return crops or shift away from agriculture altogether.

Despite being agriculturally rich, Kaithal, Karnal, and Kurukshetra have limited oilseed cultivation, ranging between 5.5 and 17.5 thousand hectares. This is mainly due to the strong presence of canal irrigation systems that favor crops like paddy and wheat, which form the basis of the region's crop rotation practices. The lower figures in oilseed production suggest that farmers here are less incentivized to adopt oilseed farming, possibly due to market conditions, procurement policies, or a lack of adequate extension services for alternative crops. Some districts show relatively better productivity despite smaller areas. For instance, Rohtak has only 15.0 thousand hectares under oilseeds but records a production of 26.3 thousand tonnes, indicating efficient crop management practices or favorable conditions during the cultivation period. Gurugram, despite its urban character, reports a noteworthy figure of 29.9 thousand hectares and 57.9 thousand tonnes, likely due to the persistence of agriculture in peripheral rural belts of the district.

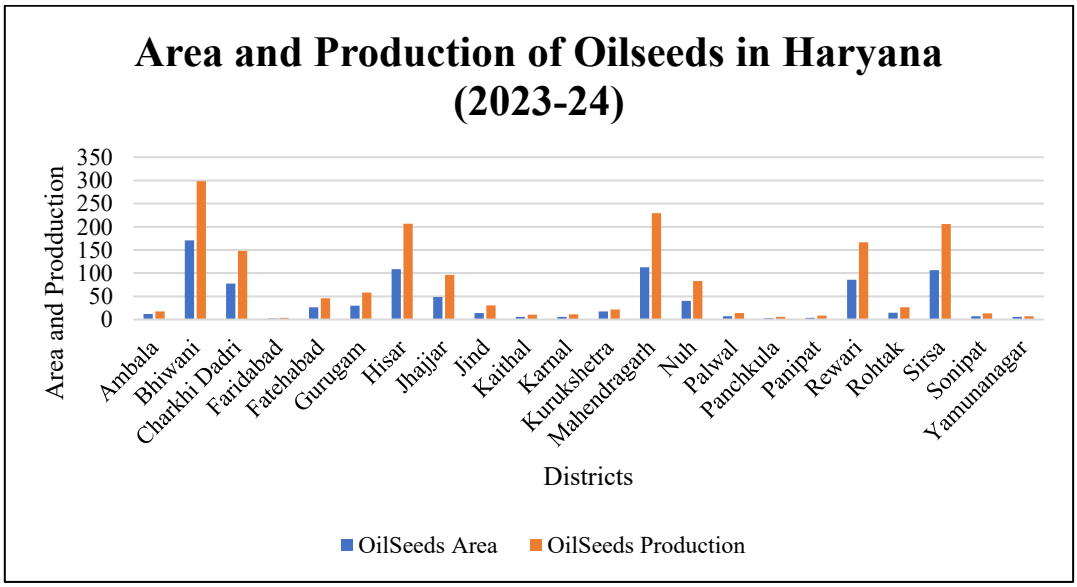


Fig 2. Area and Production of Oilseeds in Haryana (2023-24)

Source: Table No. 2

In Nuh (Mewat), the data shows 40.3 thousand hectares of oilseeds yielding 82.8 thousand tonnes. This is notable for a socio-economically backward district, suggesting potential for agricultural transformation if supported with inputs, training, and infrastructure. Similarly, Jhajjar and Fatehabad maintain a mid-level performance with 48.3 and 26.1 thousand hectares and 96.1 and 45.4 thousand tonnes, respectively. Districts such as Yamunanagar, Sonipat, and Palwal occupy the lower end of the spectrum, reflecting their geographical and land-use challenges. These districts, located in the eastern and central parts of Haryana, have seen significant industrial growth, and agricultural activities are now limited to high-value crops or shrinking plots. For example, Yamunanagar has only 5.6 thousand hectares of oilseed cultivation and a corresponding 7.1 thousand tonnes production.

IV. CONCLUSION

The comparative analysis of oilseed crop data for Haryana across two timeframes—2013–14 and 2023–24—reveals significant spatial and temporal shifts in both cultivation area and production. Over the decade, a noticeable intensification in oilseed farming has occurred, particularly in the southern and western districts of the state. Districts such as Bhiwani, Mahendragarh, Hisar, Rewari, and Sirsa consistently lead in both area under oilseed cultivation and total production. For instance, Bhiwani increased from 162.6 thousand hectares to 170.6 thousand hectares, with production rising from 265.4 to 298.1 thousand tonnes. Similarly, Mahendragarh grew from 96.7 to 112.4 thousand hectares, and production surged from 165.1 to 229.2 thousand tonnes. These figures underline these districts' sustained dominance and potential in oilseed agriculture.

On the other hand, central and eastern districts such as Karnal, Kurukshetra, Panipat, and Yamunanagar continue to show limited engagement in oilseed farming. Their comparatively small cultivation areas and production figures suggest a continued preference for other high-yield or water-intensive crops like paddy and wheat. Urbanized and industrial regions such as Gurugram and Faridabad have shown marginal increases. Still, oilseed farming remains a secondary activity due to land constraints and better economic returns from other sectors.

The emergence of Charkhi Dadri and Nuh (Mewat) as notable contributors in the 2023–24 data also reflects the spread of oilseed farming into newer areas, possibly driven by state-led crop diversification policies and the promotion of sustainable, low-water crops. Districts such as Fatehabad and Jhajjar also demonstrated moderate yet consistent growth, indicating the effectiveness of improved seed varieties, agronomic practices, and market interventions.

The data reveal an encouraging trend of increasing oilseed production across Haryana. However, the disparity between districts with high and low output indicates the need for region-specific strategies. Enhancing awareness, improving market access, and providing financial and technical support to small farmers can further boost oilseed production. Promoting oilseed crops in less saturated agricultural areas could also reduce pressure on water-intensive cropping systems, contributing to a more balanced and sustainable agrarian framework in the state. This analysis underscores the critical role of targeted policy, agronomic support, and adaptive regional planning in sustaining and expanding oilseed cultivation in Haryana.

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